YOUNG MACHINIST'S PRACTICAL GUIDE

MORSE TWIST DRILL
& MACHINE COMPANY

NEW BEDFORD, MASS.
U. S. A.

"I shall pass through this world but once. Any good thing, therefore, that I can do, or any kindness I can show to any human being, let me do it now. Let me not defer it nor neglect it, for I shall not pass this way again."

A laugh is worth a hundred groans in any market.—*Lamb.*

All honest men will bear watching. It is the rascals who cannot stand it.

Unless you want to be poor, don't try to keep all you get.

The man who sits down to wait for a golden opportunity to come along never has a comfortable seat.

A man who is not able to make a bow to his conscience every morning is not in a healthful condition.

Take time to deliberate: but when the time for action arrives, stop thinking and go on.—*Andrew Jackson.*

LOST.

"Somewhere between sunrise and sunset,
Two golden hours,
Each set with sixty diamond minutes,
No reward is offered, for they are
Lost forever."

"Keep pushing, tis wiser than sitting aside,
And sighing and watching and waiting the tide;
In life's earnest battle they only prevail,
Who daily march onward and never say fail."

It is want of diligence rather than want of means that causes most failures.—*Alfred Mercier.*

Energy and persistence conquer all things.—*Franklin.*

No man is bound to be rich or great; no, nor to be wise; but every man is bound to be honest.—*Sir Benj. Rudyard.*

Excellence is never granted to man but as the reward of labor.—*Sir Joshua Reynolds.*

If principle is good for anything, it is worth living up to. —*Franklin.*

Write your name in kindness, love and mercy on the hearts of the thousands you come in contact with, year by year, and you will never be forgotten.—*Chalmers.*

YOUNG MACHINISTS' PRACTICAL GUIDE

THE

MORSE TWIST DRILL AND
MACHINE CO.

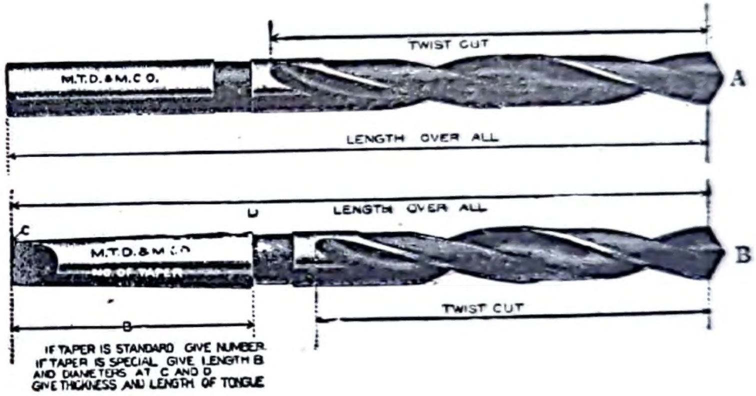
MAKERS OF

INCREASE AND CONSTANT
ANGLE TWIST DRILLS
REAMERS, CHUCKS, MILLING
CUTTERS, TAPS, DIES
MACHINERY AND
MACHINISTS' TOOLS

NEW BEDFORD, MASS., U. S. A.
1912

INDEX.

PRESS OF C. A. HACK & SON
TAUNTON, MASS., U. S. A.



IF TAPER IS STANDARD GIVE NUMBER.
IF TAPER IS SPECIAL GIVE LENGTH B AND DIAMETERS AT C AND D
GIVE THICKNESS AND LENGTH OF TONGUE

SUGGESTIONS FOR ORDERING DRILLS.

Regular Drills.—Always order by catalogue number.

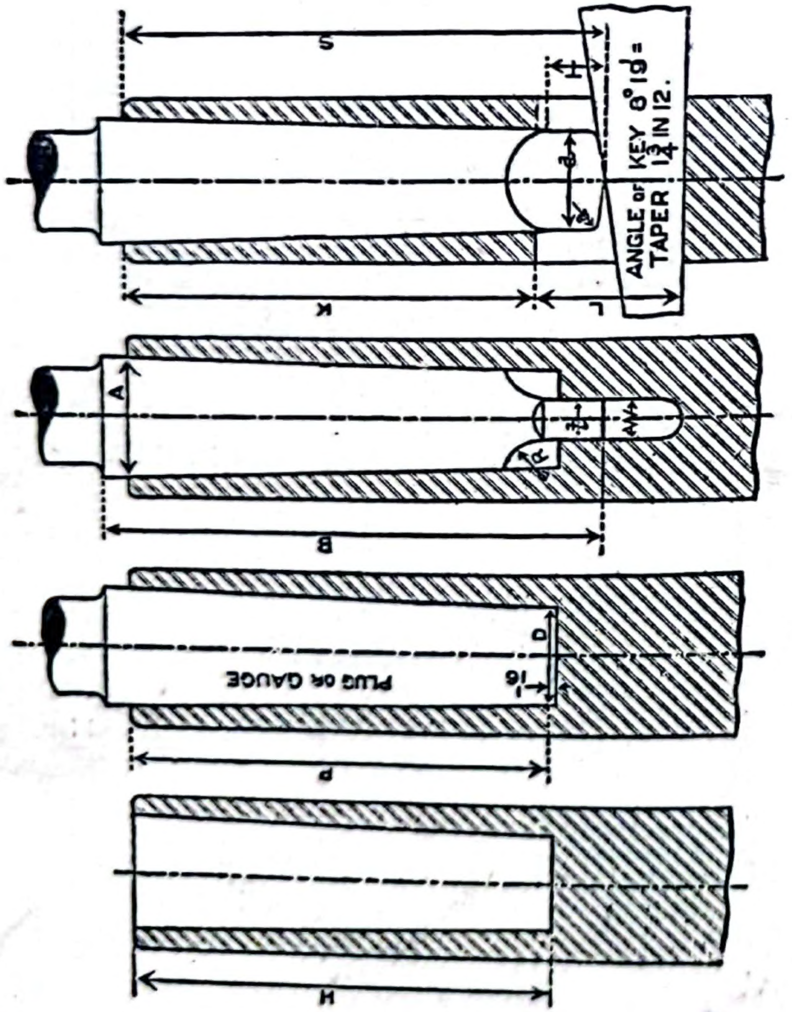
Special Drills.—Refer to the catalogue number for general style of tool required, giving also the following information:—

Special Straight Shank Drills.—Give length over all and length of twist cut. See sketch A.

Special Morse Taper Shank Drills.—Give length over all and length of twist cut. See sketch B. If a special taper shank is required, give diameter at C and D and length. See sketch B. If the shank has a tang give thickness and length. If no tang so state on the order.

We will gladly furnish copies of this page to any of our customers who desire them for distribution.

MORSE TAPERS.

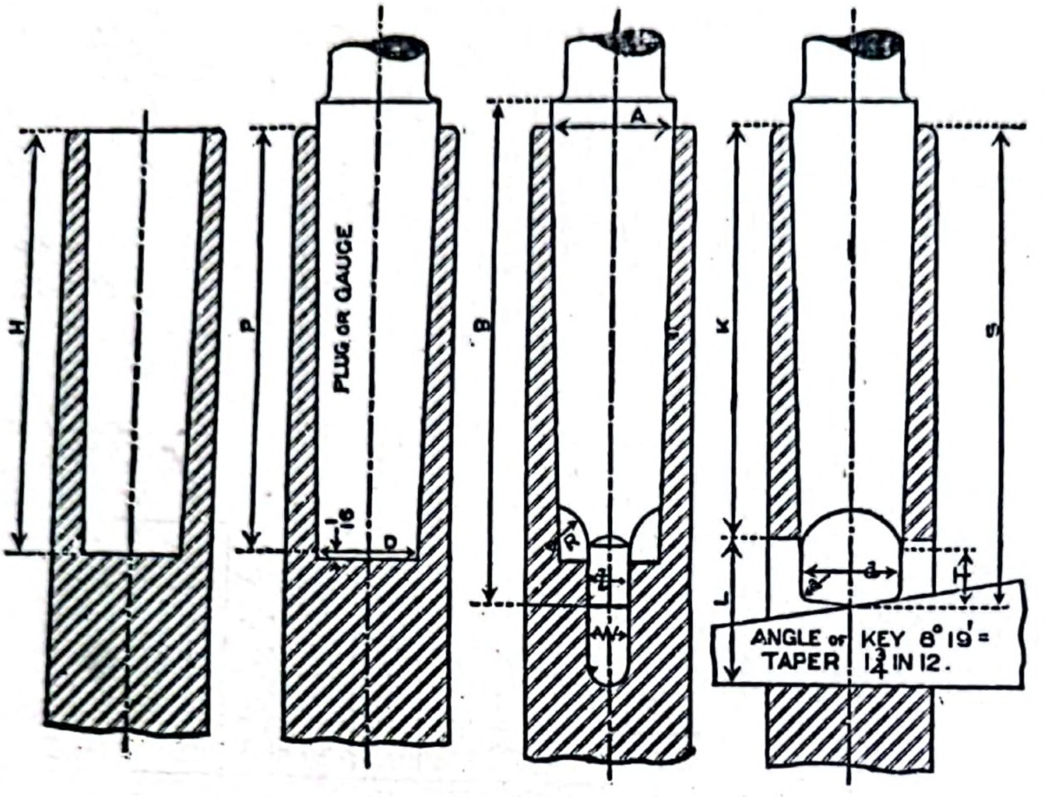


MORSE TAPERS.

	Number of Key		0	1	2	3	4	5	6	7
	Taper per Inch		.05208	.05	.05016	.05016	.05191	.0525	.05216	.05208
	Taper per Foot		.625	.600	.602	.602	.623	.630	.626	.625
	End of Socket to Keyway	K	1 15/16	2 1/16	2½	3 1/16	3⅞	4 15/16	7	9½
KEYWAY	Length of Keyway	L	9/16	¾	⅞	1 3/16	1¼	1½	1¾	2⅝
	Width of Keyway	W	.160	.213	.260	.322	.478	.635	.760	1.135
TONGUE	Radius of Tongue	a	.04	.05	.66	.08	.10	.12	.15	.18
	Diameter of Tongue	d	.235	.343	17/32	23/32	31/32	1 13/32	2	2⅝
	Rad. of Mill for Tongue	R	5/32	3/16	¼	9/32	5/16	⅜	½	¾
	Length of Tongue	T	¼	⅜	7/16	9/16	⅝	¾	1⅛	1⅜
	Thickness of Tongue	t	5/32	13/64	¼	5/16	15/32	⅝	¾	1⅛
	Standard Plug Depth	P	2	2⅛	2 9/16	3 3/16	4 1/16	5 3/16	7¼	10
	Depth of Hole	H	2 1/32	2 3/16	2⅝	3¼	4⅛	5¼	7⅜	10⅛
SHANK	Shank Depth	S	2 7/32	2 7/16	2 15/16	3 11/16	4⅝	5⅞	8¼	11¼
	Whole Length of Shank	B	2 11/32	2 9/16	3⅛	3⅞	4⅞	6⅛	8 9/16	11⅝
	Diam. at End of Socket	A	.3561	.475	.700	.938	1.231	1.748	2.494	3.270
	Diam. of Plug at small End	D	.252	.369	.572	.778	1.020	1.475	2.116	2.750
	Numer of Taper		0	1	2	3	4	5	6	7

MORSE TAPERS

SHORT SHANKS



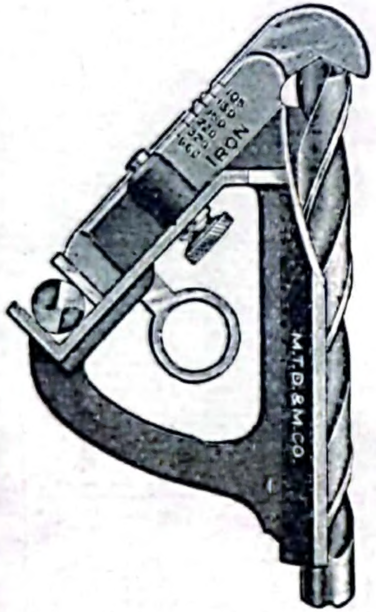
MORSE TAPERS

SHORT SHANKS

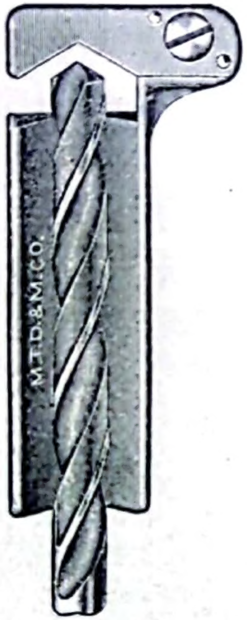
Number of Taper.	Diam. of Plug at Small End.	Diam. at End of Socket.	SHANK		Depth of Hole.	Standard Plug Depth.	TONGUE.					KEYWAY		End of Socket to Keyway.	Taper per Foot.	Taper per Inch.	Number of Key.
			Whole Length of Shank.	Shank Depth.			Thickness of Tongue.	Length of Tongue.	Rad. of Mill for Tongue.	Diameter of Tongue.	Radius of Tongue.	Width of Keyway.	Length of Keyway.				
	D	A	B	S	H	P	t	T	R	d	a	W	L	K			
0	.271	.356	1 31/32	1 27/32	1 21/32	1 5/8	.186 .188	1/4	3/16	.258	3/64	.193 .196	5/8	1 17/32	.625	.05208	0
1	.388	.475	2 3/16	2	1 13/16	1 3/4	.249 .251	5/16	1/4	.371	1/16	.260 .263	13/16	1 21/32	.600	.050	1
2	.600	.700	2 9/16	2 3/8	2 1/16	2	.374 .376	7/16	9/32	.575	1/16	.385 .388	1 3/16	1 27/32	.602	.05016	2
3	.816	.938	3 1/8	2 15/16	2 1/2	2 7/16	.499 .501	9/16	5/16	.783	3/32	.512 .516	1 5/16	2 7/32	.602	.05016	3
4	1.062	1.231	4 1/16	3 13/16	3 5/16	3 1/4	.624 .626	5/8	3/8	1.023	3/32	.637 .641	1 1/2	2 31/32	.623	.05191	4
5	1.532	1.748	5 1/16	4 13/16	4 3/16	4 1/8	.999 1.001	3/4	1/2	1.483	1/8	1.012 1.016	2	3 31/32	.630	.0525	5
6	2.201	2.494	7 1/16	6 3/4	5 3/4	5 5/8	1.248 1.251	1 1/8	5/8	2.128	1/8	1.263 1.268	2 3/4	5 1/16	.626	.05216	6
7	2.857	3.270	9 11/16	9 5/16	8 1/16	7 13/16	1.623 1.627	1 1/2	3/4	2.769	3/16	1.639 1.644	3 5/8	7 1/8	.625	.05208	7

GAUGES FOR GRINDING DRILLS

STYLE No. 1



STYLE No. 2



STYLE No. 3

STYLE No. 4

GRINDING TWIST DRILLS.

Few operations on tools in the shop are more frequently disappointing than the grinding or sharpening of drills. That the cutting edges have a proper and uniform angle with the longitudinal axis of the drill, (see Fig. 6) having them of exactly equal length, and the lips of the drill well and sufficiently backed off or cleared, are points generally understood as requisite to the satisfactory performance of a drill, though not always attained. Practical suggestions for the grinding of drills have been published from time to time. We append in part from these, hoping they will be found useful. "If the clearance of a drill is insufficient or imperfect it will not cut. When force is applied it resists the power of the drilling machine, and is crushed or split. It is well to start a drill, after grinding, by hand, observing the character of the chips, which should characterize a clean cutting tool. In wrought metal the chip will sometimes attain a length of several feet. Prof. Sweet suggests that the rear of the lip, of a drill be removed, as shown by the cut, No. 1; this makes the cutting edge much like a flat drill. Drills properly made have their

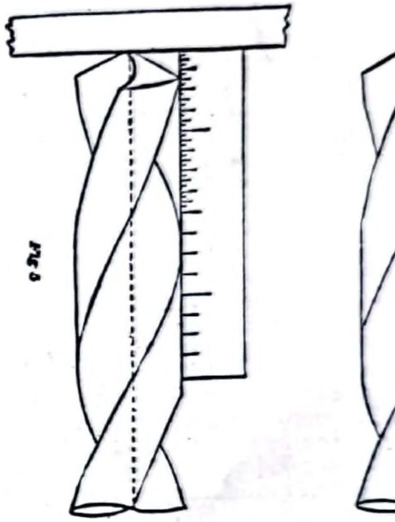


Fig 5


Fig 1


Fig 2

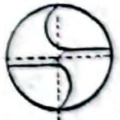


Fig 3


Fig 4

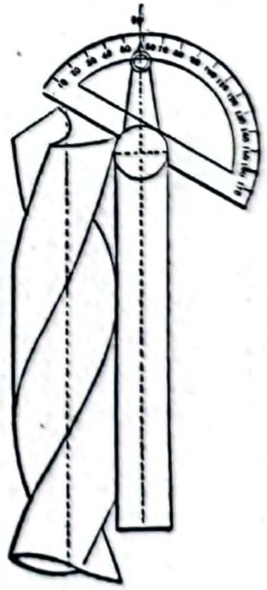


Fig 6

GRINDING TWIST DRILLS—CONTINUED.

cutting edges straight when ground to a proper angle, which is 59°, as shown in cut No. 6. Grinding to less angle leaves the lip hooking, and is likely to produce a crooked and irregular hole. The grinding lines to a drill are placed slightly above the center, to allow for the proper angle of point, which is an important factor. This angle is an index to the clearance. If the angle is too much, the drill cuts rank; if not enough, the drill may not cut. Fig. 2 shows a proper angle. In Fig. 3 the angle is too sharp. In Fig. 4 the angle runs backward, and shows the want of clearance. An effective method of determining the clearance is to set the point of the drill on a plane surface, holding a scale as shown in cut No. 5; by revolving the drill its clearance is shown, as well as the height of the cutting lips, which should be equal; also the cutting edges should be of exactly equal length,—any inequality of lengths doubles itself in work. To strengthen the drill, the center is made thicker toward the shank. As the drill is shortened through use, the centre shows thicker, and will work hard in drilling. To overcome this, the center should be thinned, care being taken to remove an equal amount of stock on each side, and so keep the point central. In grinding a drill preserve the original form, which usually will insure rapid and satisfactory work."

SPEED AND FEED OF DRILLS.
OF
CARBON STEEL.

Diam., Inches.	Revolutions Per Minute.			Diam., Inches.	Revolutions Per Minute.		
	Wrought Iron and Steel.	Cast Iron.	Brass.		Wrought Iron and Steel.	Cast Iron.	Brass.
1/16	1833	2320	3667	3/4	132	178	306
1/8	917	1160	1833	13/16	112	165	282
3/16	611	773	1222	7/8	105	153	262
1/4	458	580	917	15/16	98	143	244
5/16	342	465	733	1	90	134	229
3/8	285	386	611	1 1/16	80	126	216
7/16	244	331	524	1 1/8	75	119	204
1/2	214	290	458	1 3/16	71	113	193
9/16	176	238	407	1 1/4	67	107	183
5/8	159	214	367	1 5/16	64	102	175
11/16	144	194	333	1 3/8	61	97	167

For continuation of Table and Feeds see page 11.

SPEED AND FEED OF DRILLS
OF
CARBON STEEL

Diameter Inches	Revolutions per Minute			Diameter Inches	Revolutions per Minute		
	Wrought Iron and Steel	Cast Iron	Brass		Wrought Iron and Steel	Cast Iron	Brass
1 7/16	58	93	159	2 1/8	40	63	108
1 1/2	56	89	153	2 1/4	38	59	102
1 9/16	54	86	147	2 3/8	36	56	96
1 5/8	52	82	141	2 1/2	34	53	92
1 11/16	50	79	136	2 5/8	32	51	87
1 3/4	48	76	131	2 3/4	30	49	83
1 7/8	45	71	122	2 7/8	28	47	80
2	42	67	115	3	26	45	76
HIGH SPEED STEEL.							
1/8	1832	2440	Periphery Speed 100 to 140 feet per minute.	1 1/8	204	255	Periphery Speed 100 to 140 feet per minute.
3/16	1221	1627		1 3/16	193	242	
1/4	916	1220		1 1/4	183	229	
5/16	733	976		1 5/16	174	219	
3/8	611	813		1 3/8	166	209	
7/16	523	697		1 7/16	160	199	
1/2	458	610		1 1/2	153	191	
9/16	407	510		1 9/16	143	184	
5/8	366	459		1 5/8	138	176	
11/16	333	417		1 3/4	127	164	
3/4	305	383		1 7/8	112	153	
13/16	282	353		2	104	143	
7/8	262	328		2 1/8	95	126	
15/16	244	306		2 1/4	89	118	
1	229	287		2 3/8	80	112	
1 1/16	215	270		2 1/2	76	106	

FEED PER REVOLUTION.

CARBON STEEL DRILLS.		HIGH SPEED STEEL DRILLS
.005"	1/4"	.006"
.009"	3/8"	.010"
.012"	1	.015"
.015"	2	.020"

The above Speeds and Feeds are approximate for average conditions. They can be greatly exceeded under some conditions but under others both would have to be reduced.

DECIMAL EQUIVALENTS OF NOMINAL SIZES OF DRILLS.

Inch.	M.M.	Wire Gauge	Decimals of an Inch.
		80	0135
		79	0145
1/64			.015625
	.4		.01574
		78	.016
		77	018
	5		01968
		76	020
		75	021
	.55		0216
		74	0225
	6		.02362
		73	.024
		72	.025
	65		0256
		71	026
	.7		.02756
		70	028
		69	.02925
	.75		.0296
		68	.031
1/32			.03125
	.8		.031496
		67	032
		66	033
	.85		0335
		65	035
	9		03543
		64	036
		63	037
	95		0374
		62	038
		61	039
	1		03937
		60	04
		59	041
	1 05		0413
		58	.042
		57	.043
	1 1		.043307
	1 15		.0453
		56	.0465
3/64			.046875
	1 2		.047244
	1 25		.0492
	1 3		051181
		55	.052
	1.35		0532
		54	055
	1.4		.055118
	1 45		.0571
	1.5		.05905
		53	.0595
	1.55		.061
1/16			.0625
	1 6		.06299
		52	0635
	1 65		.065
	1 7		.066929
		51	.067
	1 75		.0689
		50	.07
	1.8		.070866
	1.85		.0728
		49	.073
	1 9		.0748
		48	.076
	1 95		0768
5/64			.078125
		47	.0785
	2		.07874
	2.05		.0807
		46	.081
		45	.082
	2 1		.0826
	2.15		.0846
		44	086
	2.2		.0866
	2.25		.0886
		43	.089
	2.3		.0905
	2.35		.0925
		42	0935
3/32			.09375
	2 4		.09448
		41	.096
	2 45		.0965
		40	098
	2.5		.098425
		39	.0995
		38	1015
	2 6		102362
		37	104
	2.7		1063
		36	1065
7/64			.109375
		35	11
	2.8		11024
		34	111
		33	113
	2 9		11417
		32	116
	3		11811
		31	12
	3 1		.12205
⅛			125
	3.2		.12598
		30	.1285
	3.3		.12992
	3.4		.13386
		29	.136

DECIMAL EQUIVALENTS OF NOMINAL SIZES OF DRILLS.

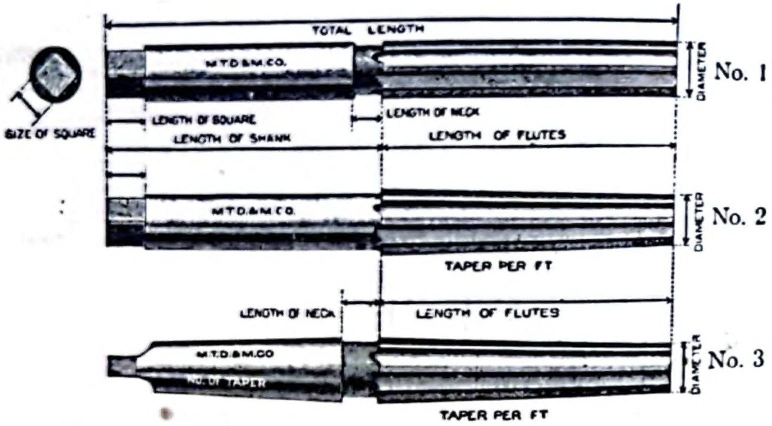
Inch.	M.M.	Wire Gauge	Decimals of an Inch.
	3.5		.1378
		28	.1405
9/64			.140625
	3.6		.14173
		27	.144
	3.7		.14567
		26	.147
		25	.1495
	3.8		.14961
		24	.152
	3.9		.15354
		23	.154
5/32			.15625
		22	.157
	4		.15748
		21	.159
		20	.161
	4.1		.16142
	4.2		.16536
		19	.166
	4.3		.16929
		18	.1695
11/64			.171875
		17	.173
	4.4		.17323
		16	.177
	4.5		.17717
		15	.18
	4.6		.1811
		14	.182
		13	.185
	4.7		.18504
3/16			.1875
	4.8		.18898
		12	.189
		11	.191
	4.9		.19291
		10	.1935
		9	.196
	5		.19685
		8	.199
	5.1		.20079
		7	.201
13/64			.203125
		6	.204
	5.2		.20473
		5	.2055
	5.3		.20866
		4	.209
	5.4		.2126
		3	.213
	5.5		.21654
7/32			.21875
	5.6		.22047
		2	.221
	5.7		.22441
		1	.228
		Letter Sizes.	
	5.8		.22835
	5.9		.23228
		A	.234
15/64			.234375
	6		.23622
		B	.238
	6.1		.24015
		C	.242
	6.2		.2441
		D	.246
	6.3		.24803
¼		E	.25
	6.4		.25197
	6.5		.25591
		F	.257
	6.6		.25984
		G	.261
	6.7		.26377
17/64			.265625
		H	.266
	6.8		.26772
	6.9		.27165
		I	.272
	7		.27559
		J	.277
	7.1		.27952
		K	.281
9/32			.28125
	7.2		.28347
	7.3		.2874
		L	.29
	7.4		.29133
		M	.295
	7.5		.29528
19/64			.296875
	7.6		.29922
		N	.302
	7.7		.30314
	7.8		.30709
	7.9		.31102
5/16			.3125
	8		.31496
		O	.316
	8.1		.3189
	8.2		.32284
	8.3		.3268
		P	.323
21/64			.328125
	8.4		.3307
		Q	.332
	8.5		.33465
	8.6		.33859

DECIMAL EQUIVALENTS OF NOMINAL SIZES OF DRILLS.

Inch.	M. M.	Letter Sizes.	Decimals of an Inch.	Inch.	M. M.	Decimals of an Inch.	Inch.	M. M.	Decimals of an Inch.
		R	.339		12.5	.4921	13/16		.8125
	8.7		.3425	½		.5		21	.82677
11/32			.34375		13	.51181	53/64		.828125
	8.8		.3464	33/64		.515625	27/32		.84375
		S	.348	17/32		.53125		21.5	.84646
	8.9		.3504		13.5	.5315	55/64		.859375
	9		.3543	35/64		.546875		22	.86614
		T	.358		14	.55118	⅞		.875
	9.1		.3583	9/16		.5625		22.5	.88583
23/64			.359375		14.5	.57087	57/64		.890625
	9.2		.36221	37/64		.578125		23	.90551
	9.3		.3661		15	.59055	29/32		.90625
		U	.368	19/32		.59375	59/64		.921875
	9.4		.3701	39/64		.609375		23.5	.9252
	9.5		.37402		15.5	.61024	15/16		.9375
⅜			.375	⅝		.625		24	.94488
		V	.377		16	.62992	61/64		.953125
	9.6		.37796	41/64		.640625		24.5	.9646
	9.7		.3819		16.5	.6496	31/32		.96875
	9.8		.38583	21/32		.65625		25	.98425
		W	.386		17	.66929	63/64		.984375
	9.9		.3898	43/64		.671875	1		1.
25/64			.390625	11/16		.6875		25.5	1.004
	10		.3937		17.5	.689	1 1/64		1.015625
		X	.397	45/64		.703125		26	1.02362
		Y	.404		18	.70866	1 1/32		1.03125
13/32			.40625	23/32		.71875		26.5	1.0433
		Z	.413		18.5	.72835	1 3/64		1.046875
	10.5		.4134	47/64		.734375	1 1/16		1.0625
27/64			.421875		19	.74803		27	1.063
	11		.43307	¾		.75	1 5/64		1.078125
7/16			.4375	49/64		.765625		27.5	1.08268
	11.5		.45276		19.5	.76772	1 3/32		1.09375
29/64			.453125	25/32		.78125		28	1.1024
15/32			.46875		20	.7874	1 7/64		1.109375
	12		.47244	51/64		.796875		28.5	1.122
31/64			.484375		20.5	.8071	1 ⅛		1.125

DECIMAL EQUIVALENTS OF NOMINAL SIZES OF DRILLS.

Inch.	M. M.	Decimals of an Inch.	Inch.	M. M.	Decimals of an Inch.	Inch.	M. M.	Decimals of an Inch.
1 9/64		1.140625		37	1.4567	1 25/32		1.78125
	29	1.1417	1 15/32		1.46875		45.5	1.79138
1 5/32		1.15625		37.5	1.4764	1 51/64		1.79687
	29.5	1.1614	1 31/64		1.48437		46	1.811
1 11/64		1.171875		38	1.4961	1 13/16		1.8125
	30	1.1811	1 ½		1.5	1 53/64		1.82812
1 3/16		1.1875	1 33/64		1.51562		46.5	1.83
	30.5	1.2008		38.5	1.51576	1 27/32		1.84375
1 13/64		1.203125	1 17/32		1.53125		47	1.85047
1 7/32		1.21875		39	1.5354	1 55/64		1.85937
	31	1.2205	1 35/64		1.54687		47.5	1.87016
1 15/64		1.234375		39.5	1.5551	1 ⅞		1.875
	31.5	1.24016	1 9/16		1.5625		48	1.88985
1 ¼		1.25		40	1.5748	1 57/64		1.89062
	32	1.2598	1 37/64		1.57812	1 29/32		1.90625
1 17/64		1.26562	1 19/32		1.59375		48.5	1.90945
	32.5	1.2795		40.5	1.5945	1 59/64		1.92187
1 9/32		1.28125	1 39/64		1.60937		49	1.92913
1 19/64		1.29687		41	1.6142	1 15/16		1.9375
	33	1.2992	1 ⅝		1.625		49.5	1.9488
1 5/16		1.3125		41.5	1.6338	1 61/64		1.95312
	33.5	1.319	1 41/64		1.64062		50	1.9685
1 21/64		1.328125		42	1.6536	1 31/32		1.96875
	34	1.3386	1 21/32		1.65625	1 63/64		1.98437
1 11/32		1.34375	1 43/64		1.67187		50.5	1.9882
	34.5	1.3583		42.5	1.6733	2		2.
1 23/64		1.359375	1 11/16		1.6875		51	2.0079
1 ⅜		1.375		43	1.6929	2 1/64		2.0156
	35	1.378	1 45/64		1.70312		51.5	2.0276
1 25/64		1.39062		43.5	1.71259	2 1/32		2.0312
	35.5	1.3977	1 23/32		1.71875	2 3/64		2.0468
1 13/32		1.40625		44	1.7323		52	2.0473
	36	1.4173	1 47/64		1.73437	2 1/16		2.0625
1 27/64		1.421875	1 ¾		1.75		52.5	2.0670
	36.5	1.437		44.5	1.7519	2 5/64		2.0781
1 7/16		1.4375	1 49/64		1.76562		53	2.0866
1 29/64		1.45312		45	1.7717	2 3/32		2.0937



SUGGESTIONS FOR ORDERING REAMERS.

Regular Reamers.—Always order by catalogue number.

Special Reamers.—Refer to the catalogue number for general style of tool required, giving also the following information:—

Special Solid Reamers.—Give total length and length of flutes. See sketch No. 1.

Special Taper Reamers.—Give whole length, length of flutes, size at large and small ends of flutes; or size at one end and taper per foot. State whether style No. 2 or No. 3 is required. If style No. 3 give dimensions of taper shank or if Morse Taper is required state number.

Special Shell Reamers.—Give whole length and length of flutes. When these reamers are longer than catalogue lengths they are made with Straight Hole and diameter of hole should be given.

We will gladly furnish copies of this page to any of our customers who desire them for distribution.

TO SHARPEN REAMERS.

Hand Reamers. when dull through wear, should be stoned first on the face of the flutes then on top of the flutes. The stone should be always held perfectly flat with the face and clearance that the original shape of the flutes may be preserved.

End Cutting Reamers should be first ground on centres with a wheel, and then recleared to insure reaming a hole the same size of Reamer.

The Norton Co. make a Stone for the purpose, which is adapted and gives quicker results than any oil stone. The stone should be kept clean by the use of turpentine.

SUGGESTIONS FOR ORDERING TAPS.

Regular Taps. Always order by catalogue number. Unless specified to the contrary we fill all orders with U. S. form of thread.

Special Taps. Give exact diameter of thread, whole length and length of thread, number of threads to the inch. Also state whether V, U. S. S., or Whitworth shape of thread is desired. Reference should also be made to catalogue number showing style.

When **Hand Taps** are ordered state whether Taper, Plug or Bottoming.

SPECIAL DIES.

If for **Screw Plates**, give number of plate, size of die together with number of threads to the inch and shape of thread.

If **Solid Dies**, give size, number and shape of thread, and square and thickness.

If **Round Dies**, give diameter and thickness and state whether split or solid.

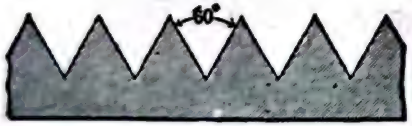
If sizes of Taps and Dies cannot be accurately given, a plug showing what is required should be furnished.

See page 27 for general information relating to Stay Bolt Taps.

UNITED STATES OR FRANKLIN INSTITUTE STANDARD.

Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.
¼	20	1	8	2⅛	4½	3⅛	3½
5⁄16	18	1⅛	7	2¼	4½	3¼	3½
⅜	16	1¼	7	2⅜	4	3⅜	3¼
7⁄16	14	1⅜	6	2½	4	3½	3¼
½	13	1½	6	2⅝	4	3⅝	3¼
9⁄16	12	1⅝	5½	2¾	4	3¾	3
⅝	11	1¾	5	2⅞	3½	3⅞	3
¾	10	1⅞	5	3	3½	4	3
⅞	9	2	4½				

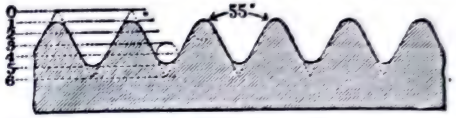
TAP THREADS.—V THREAD.



Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.
¼	20	1	8	2	4½	3	3½
5⁄16	18	1⅛	7	2⅛	4½	3⅛	3½
⅜	16	1¼	7	2¼	4½	3¼	3½
7⁄16	14	1⅜	6	2⅜	4½	3⅜	3¼
½	12	1½	6	2½	4	3½	3¼
⅝	11	1⅝	5	2⅝	4	3⅝	3¼
¾	10	1¾	5	2¾	4	3¾	3
⅞	9	1⅞	4½	2⅞	4	3⅞	3
						4	3

There is no recognized standard number of threads for diameters less than ¼ inch.

TAP THREADS.—WHITWORTH STANDARD.



Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch	Diam. of Tap, Inches.	No. of Threads to Inch.	Diam. of Tap, Inches.	No. of Threads to Inch.
¼	20	1	8	2	4½	3	3½
5⁄16	18	1⅛	7	2⅛	4½	3⅛	3½
⅜	16	1¼	7	2¼	4	3¼	3¼
7⁄16	14	1⅜	6	2⅜	4	3⅜	3¼
½	12	1½	6	2½	4	3½	3¼
⅝	11	1⅝	5	2⅝	4	3⅝	3¼
¾	10	1¾	5	2¾	3½	3¾	3
⅞	9	1⅞	4½	2⅞	3½	3⅞	3
						4	3

ACME STANDARD.

29° THREAD.

This Thread has been devised to take the place of the Square Thread. It has the same depth as the Square Thread, but is stronger, as the bottom of the thread is wider than the Square Thread. The sides of this Thread are at the same inclination as is now generally adopted in cutting Worms.

Taps and Dies to this Standard are made only to order, and prices will be given on application.

TABLE OF THREAD PARTS.

No. of Threads, per Inch.	Depth of Thread.	Thickness at Top of Thread.	Width Space at Bottom of Thread.	Space at Top of Thread.	Thickness at Root of Thread.
1	.5100	.3707	.3655	.6293	.6345
1⅓	.3850	.2880	.2728	.4720	.4772
2	.2600	.1853	.1801	.3147	.3199
3	.1767	.1235	.1183	.2098	.2150
4	.1350	.0927	.0875	.1573	.1625
5	.1100	.0741	.0689	.1259	.1311
6	.0933	.0618	.0566	.1049	.1101
7	.0814	.0529	.0478	.0899	.0951
8	.0725	.0463	.0411	.0787	.0839
9	.0655	.0413	.0361	.0699	.0751
10	.0600	.0371	.0319	.0629	.0681

TABLE FOR USE WITH
SCREW THREAD MICROMETER CALIPER.

READING OF CALIPER.

For U. S. S. threads, $D - \frac{.6495}{P}$ For " V " threads, $D - \frac{.866}{P}$.

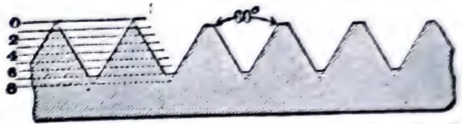
U. S. Std. Threads				" V " Threads			
Diameter	Pitch	Caliper Reading		Diameter	Pitch	Caliper Reading	
D	P	$D - \frac{.6495}{P}$	$\frac{.6495}{P}$	D	P	$D - \frac{.866}{P}$	$\frac{.866}{P}$
¼	20	2176	0324	¼	24	.2139	0361
5/16	18	2765	.0360	¼	20	.2067	0433
⅜	16	.3344	.0406	5/16	20	.2692	.0433
7/16	14	.3911	.0464	5/16	18	.2644	.0481
½	13	.4501	0499	⅜	18	.3269	0481
9/16	12	.5084	.0541	⅜	16	.3209	0541
⅝	11	.566	0590	7/16	16	.3834	.0541
¾	10	.6851	0649	7/16	14	.3756	0619
⅞	9	.8029	.0721	½	14	.4381	.0619
1	8	9188	0812	½	13	.4334	0666
1⅛	7	1.0322	0928	½	12	.4278	0722
1¼	7	1.1572	.0928	9/16	14	.5006	0619
1⅜	6	1 2668	1082	9/16	12	.4903	0722
1½	6	1.3918	1082	⅝	11	.5463	0787
1⅝	5½	1.507	.1180	⅝	10	.5384	.0866
1¾	5	1.6201	1299	11/16	10	.6009	0866
1⅞	5	1.7451	1299	¾	10	.6634	.0866
2	4½	1 8557	1443	⅞	9	.7788	.0962
2½	4	2.3376	1624	1	8	.8918	.1082
3	3½	2.8145	1855	1⅛	8	1.0168	.1082
3½	3¼	3 3002	1998	1¼	7	1.1263	.1237
4	3	3 7835	2165	1½	6	1.3557	.1443

The right hand column gives the number to be subtracted from the diameter to obtain the caliper reading

The figures in above table apply only to screws made accurately to standard size.

Taps are always made oversize, screws as well as taps, having the V Form of Thread are usually made considerably larger than the figures in above table.

A. S. M. E. STANDARD.
FOR MACHINE SCREWS.



This standard for machine screws was recommended by the American Society of Mechanical Engineers at the Indianapolis meeting, May 28–31, 1907.

For full and complete details concerning this standard and the Engineers' recommendations, see their report, Volume 28, No. 9.

We are prepared to furnish machine screw taps made to these figures.

STANDARD SCREWS.

Note:—Maximum sizes given are the standard sizes.

Basic Size.		Outside Diameter.		Pitch Diameter		Root Diameter	
No.	O.D.—T.P.I.	Min.	Max.	Min.	Max.	Min.	Max.
0	.060–80	.0572	.0600	.0505	.0519	.0410	.0438
1	.073–72	.0700	.0730	.0625	.0640	.0520	.0550
2	.086–64	.0828	.0860	.0742	.0759	.0624	.0657
3	.099–56	.0955	.0990	.0857	.0874	.0721	.0758
4	.112–48	.1082	.1120	.0966	.0985	.0808	.0849
5	.125–44	.1210	.1250	.1082	.1102	.0910	.0955
6	.138–40	.1338	.1380	.1197	.1218	.1007	.1055
7	.151–36	.1466	.1510	.1308	.1330	.1097	.1149
8	.164–36	.1596	.1640	.1438	.1460	.1227	.1279
9	.177–32	.1723	.1770	.1544	.1567	.1307	.1364
10	.190–30	.1852	.1900	.1660	.1684	.1407	.1467
12	.216–28	.2111	.2160	.1903	.1928	.1633	.1696
14	.242–24	.2368	.2420	.2123	.2149	.1807	.1879
16	.268–22	.2626	.2680	.2358	.2385	.2013	.2090
18	.294–20	.2884	.2940	.2587	.2615	.2208	.2290
20	.320–20	.3144	.3200	.2847	.2875	.2468	.2550
22	.346–18	.3402	.3460	.3070	.3099	.2649	.2738
24	.372–16	.3660	.3720	.3284	.3314	.2810	.2908
26	.308–16	.3920	.3980	.3544	.3574	.3070	.3168
28	.424–14	.4178	.4240	.3745	.3776	.3204	.3312
30	.450–14	.4438	.4500	.4005	.4036	.3464	.3572

A. S. M. E. STANDARD.

SPECIAL SCREWS.

NOTE:—Maximum sizes given are the standard sizes.

Basic Size		Outside Diameter		Pitch Diameter.		Root Diameter	
No.	O.D.—T.P.I.	Min.	Max.	Min.	Max.	Min.	Max.
1	.073–64	.0698	.0730	.0612	.0629	.0494	.0527
2	.086–56	.0825	.0860	.0727	.0744	.0591	.0628
3	.099–48	.0952	.0990	.0836	.0855	.0678	.0719
4	.112–40	.1078	.1120	.0937	.0958	.0747	.0795
	.112–36	.1076	.1120	.0918	.0940	.0707	.0759
5	.125–40	.1208	.1250	.1067	.1088	.0877	.0925
	.125–36	.1206	.1250	.1048	.1070	.0837	.0889
6	.138–36	.1336	.1380	.1178	.1200	.0967	.1019
	.138–32	.1333	.1380	.1154	.1177	.0917	.0974
7	.151–32	.1463	.1510	.1284	.1307	.1047	.1104
	.151–30	.1462	.1510	.1269	.1294	.1017	.1077
8	.164–32	.1593	.1640	.1414	.1437	.1177	.1234
	.164–30	.1592	.1640	.1399	.1423	.1147	.1207
9	.177–30	.1722	.1770	.1529	.1553	.1277	.1337
	.177–24	.1718	.1770	.1473	.1499	.1158	.1229
10	.190–32	.1853	.1900	.1674	.1697	.1437	.1494
	.190–24	.1848	.1900	.1603	.1629	.1287	.1359
12	.216–24	.2108	.2160	.1863	.1889	.1547	.1619
14	.242–20	.2364	.2420	.2067	.2095	.1688	.1770
16	.268–20	.2624	.2680	.2327	.2355	.1948	.2030
18	.294–18	.2882	.2940	.2550	.2579	.2120	.2218
20	.320–18	.3142	.3200	.2810	.2830	.2380	.2478
22	.346–16	.3400	.3460	.3024	.3054	.2550	.2648
24	.372–18	.3662	.3720	.3330	.3350	.2909	.2998
26	.398–14	.3918	.3980	.3485	.3516	.2944	.3052
28	.424–16	.4180	.4240	.3804	.3834	.3330	.3482
30	.450–16	.4440	.4500	.4064	.4094	.3590	.3688

SIZES OF TAP DRILLS

FOR TAPS MADE BY

MORSE TWIST DRILL AND MACHINE COMPANY,

NEW BEDFORD, MASS.

FOR TAPS WITH "V" THREAD.

Diam. Tap, in Ins.	Thds. per Inch.	Size of Drill, No.	Diam. Tap. in Ins.	Thds. per Inch.	Size of Drill.	Diam. Tap. in Ins.	Thds. per Inch.	Size of Drill, Ins.	Diam. Tap, in Ins.	Thds. per Inch.	Size of Drill, Ins.
3/32	48	50	7/32	24	No. 20	19/32	12	31/64	1 7/32	7	1 1/64
3/32	52	50	7/32	28	No. 17	19/32	14	1/2	1 7/32	8	1 [illegible]
3/32	54	49	7/32	30	No. 16	5/8	10	31/64	1 1/4	7	1 [illegible]
3/32	56	49	7/32	32	No. 15	5/8	11	1/2	1 9/32	7	1 [illegible]
3/32	60	48	15/64	24	No. 16	5/8	12	[illegible]	1 5/16	7	1 [illegible]
7/64	32	50	15/64	28	No. 12	21/32	10	[illegible]	1 11/32	7	1 [illegible]
7/64	36	49	15/64	32	No. 10	21/32	11	[illegible]	1 3/8	6	1 1/8
7/64	40	47	1/4	18	No. 17	21/32	12	[illegible]	1 13/32	6	1 [illegible]
7/64	48	44	1/4	20	No. 14	11/16	11	[illegible]	1 7/16	6	1 [illegible]
7/64	56	43	1/4	24	No. 9	11/16	12	[illegible]	1 15/32	6	1 [illegible]
1/8	32	44	9/32	16	No. 10	23/32	11	[illegible]	1 1/2	6	1 [illegible]
1/8	36	43	9/32	18	13/64 in.	23/32	12	[illegible]	1 17/32	6	1 [illegible]
1/8	40	42	9/32	20	No. 3	3/4	10	[illegible]	1 9/16	6	1 [illegible]
1/8	42	41	5/16	16	No. 1	3/4	11	5/8	1 19/32	6	1 [illegible]
1/8	48	39	5/16	18	15/64 in.	3/4	12	[illegible]	1 5/8	5	1 [illegible]
9/64	30	41	11/32	16	F	25/32	10	[illegible]	1 5/8	5½	1 [illegible]
9/64	32	40	11/32	18	17/64 in.	25/32	11	[illegible]	1 21/32	5	1 [illegible]
9/64	36	37	3/8	14	J	25/32	12	[illegible]	1 21/32	5½	1 [illegible]
9/64	40	34	3/8	16	L	[illegible]	10	[illegible]	1 11/16	5	1 [illegible]
5/32	30	33	3/8	18	19/64 in.	[illegible]	10	[illegible]	1 11/16	5½	1 [illegible]
5/32	32	32	13/32	14	N	7/8	9	[illegible]	1 23/32	5	1 [illegible]
5/32	36	31	13/32	16	P	7/8	10	[illegible]	1 23/32	5½	1 [illegible]
5/32	40	30	13/32	18	21/64 in.	[illegible]	9	3/4	1 3/4	5	1 [illegible]
[illegible]	32	30	7/16	14	R	[illegible]	9	[illegible]	1 25/32	5	1 [illegible]
[illegible]	36	29	7/16	16	S	[illegible]	9	[illegible]	1 13/16	5	1 [illegible]
[illegible]	40	28	15/32	14	3/8	1	8	[illegible]	1 27/32	5	1 [illegible]
3/16	24	29	15/32	16	W	1 1/32	8	[illegible]	1 7/8	4½	1 [illegible]
3/16	28	28	1/2	12	25/64 in.	1 1/16	8	[illegible]	1 7/8	5	1 [illegible]
3/16	30	27	1/2	13	X	1 3/32	8	[illegible]	1 29/32	4½	1 [illegible]
3/16	32	26	1/2	14	[illegible] in.	1 1/8	7	[illegible]	1 29/32	5	1 [illegible]
3/16	36	24	17/32	12	[illegible] in.	1 1/8	8	[illegible]	1 15/16	4½	1 [illegible]
[illegible]	24	26	17/32	13	[illegible] in.	1 5/32	7	[illegible]	1 15/16	5	1 [illegible]
[illegible]	28	22	17/32	14	[illegible] in.	1 5/32	8	[illegible]	1 31/32	4½	1 [illegible]
[illegible]	32	20	9/16	12	[illegible] in.	1 3/16	7	[illegible]	1 31/32	5	1 [illegible]
[illegible]	36	18	9/16	14	[illegible] in.	1 3/16	8	1 1/64	2	4½	1 [illegible]

SIZES OF TAP DRILLS.

FOR TAPS WITH U. S. STANDARD THREADS.

Diam. Tap, in Ins.	Thds. per In.	Size of Drill.	Diam. Tap, in Ins.	Thds. per In.	Size of Drill, Ins.	Diam. Tap, in Ins.	Thds. per Inch.	Size of Drill, Ins.	Diam. Tap. in Ins.	Thds. per Inch.	Size of Drill, Ins.
1/4	20	3/16 in	11/16	11	37/64	1 1/4	7	1 5/64	2 1/8	4 1/2	1 27/32
5/16	18	C	3/4	10	5/8	1 3/8	6	1 11/64	2 1/4	4 1/2	1 31/32
3/8	16	N	13/16	10	11/16	1 1/2	6	1 19/64	2 3/8	4	2 1/16
7/16	14	S	7/8	9	47/64	1 5/8	5 1/2	1 25/64	2 1/2	4	2 3/16
1/2	13	13/32 in.	15/16	9	51/64	1 3/4	5	1 1/2			
9/16	12	29/64 in.	1	8	27/32	1 7/8	5	1 5/8			
5/8	11	33/64 in.	1 1/8	7	61/64	2	4 1/2	1 23/32			

FOR MACHINE SCREW TAPS.

Size of Tap, Number.	Size of Drill, Number.	Size of Tap, Number.	Size of Drill, Number.	Size of Tap, Number	Size of Drill, Number.	Size of Tap, Number.	Size of Drill, Number
2 x 48	50	7 x 32	30	13 x 20	15	18 x 20	A
2 x 56	49	8 x 24	30	13 x 22	15	19 x 16	B
2 x 64	48	8 x 30	30	13 x 24	13	19 x 18	C
3 x 40	47	8 x 32	29	14 x 20	13	19 x 20	D
3 x 48	45	9 x 24	29	14 x 22	11	20 x 16	D
3 x 56	44	9 x 28	28	14 x 24	9	20 x 18	F
4 x 32	43	9 x 30	27	15 x 18	10	20 x 20	H
4 x 36	42	9 x 32	25	15 x 20	8	22 x 16	J
4 x 40	41	10 x 24	25	15 x 22	6	22 x 18	L
5 x 30	40	10 x 30	22	15 x 24	5	24 x 14	M
5 x 32	40	10 x 32	21	16 x 16	7	24 x 16	N
5 x 36	38	11 x 24	21	16 x 18	6	24 x 18	O
5 x 40	37	11 x 28	17	16 x 20	5	26 x 14	O
6 x 30	35	11 x 30	17	17 x 16	6	26 x 16	P
6 x 32	35	12 x 20	19	17 x 18	2	28 x 14	R
6 x 36	33	12 x 22	17	17 x 20	2	28 x 16	S
6 x 40	32	12 x 24	17	18 x 16	2	30 x 14	U
7 x 28	32	12 x 28	15	18 x 18	1	30 x 16	V
7 x 30	31						

For Steel work use one or two sizes of drills larger than listed above.

TAP DRILLS.

FOR MACHINE SCREW TAPS.

A. S. M. E. STANDARD.

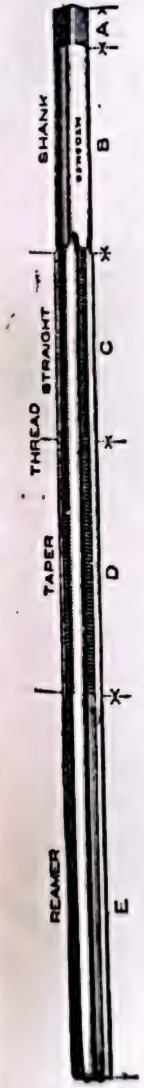
The diameter given for each hole to be tapped allows for a practical clearance at the root of the thread of the screw and will not impose undue strain upon the tap in service.

Size of Tap.	Number of Threads.	Size of Drill.	Size of Tap.	Number of Threads.	Size of Drill.
0	80	.0465	9	32	.1405
1	64	.055	10	24	.140
1	72	.0595	10	30	.152
2	56	.0670	10	32	.154
2	64	.070	12	24	.166
3	48	.076	12	28	.173
3	56	.0785	14	20	.182
4	36	.080	14	24	.1935
4	40	.082	16	20	.209
4	48	.089	16	22	.213
5	36	.0935	18	18	.228
5	40	.098	18	20	.234
5	44	.0995	20	18	.257
6	32	.1015	20	20	.261
6	36	.1065	22	16	.272
6	40	.110	22	18	.281
7	30	.113	24	16	.295
7	32	.116	24	18	.302
7	36	.120	26	14	.316
8	30	.1285	26	16	.323
8	32	.1285	28	14	.339
8	36	.136	28	16	.348
9	24	.1285	30	14	.368
9	30	.136	30	16	.377

BRIGGS' STANDARD.

Size of Tap.	No. of Threads Per Inch.	Size of Hole Before Tapping.	Length of Thread on Pipe.	Outside Diameter of Pipe.
⅛	27	11/32	9/32	.405
¼	18	7/16	⅜	.540
⅜	18	9/16	7/16	.675
½	14	45/64	½	.840
¾	14	15/16	9/16	1.050
1	11½	1 3/16	⅝	1.315
1¼	11½	1½	11/16	1.660
1½	11½	2 31/32	11/16	1.900
2	11½	2 3/16	⅞	2.375
2½	8	2 41/64	1	2.875
3	8	3¼	1	3.500
3½	8	3 25/32	1 1/16	4.000
4	8	4 9/32	1⅛	4.500
4½	8	4¾	1¼	5.000
5	8	5 21/64	1⅜	5.563
6	8	6⅜	1½	6.625
7	8	7⅜	1⅝	7.625
8	8	8⅜	1¾	8.625
9	8	9⅜	1¾	9.688
10	8	10 7/16	1⅞	10.750
12	8	12 15/32	1⅞	12.750

STAY BOLT TAPS FOR BOILER WORK.



In ordering, state diameter, pitch and form of thread, also lengths of parts A, B, C, D and E.

These Taps will be furnished in either U. S. form or V form of thread, 12 to the inch at regular list and discount.

Diameter given is that of the thread at its straight part.

Taps shorter than 16 inches will be charged as if 16 inches long.

When ordering specify form of thread desired.

Blank order slips furnished on application.

The Table of Lengths given below is one made up of average lengths taken from a large number of orders, and is listed merely as a suggestion or aid in making up specifications.

AVERAGE LENGTHS.

Whole Length of Tap, Inches.	Length, Inches.				
	A	B	C	D	E
12	1	3	3	2½	2½
14	1	4	3	3	3
16	1	4½	3	3½	4
18	1	5	3½	4	4½
21	1	6	4	4½	5½
24	1	8	4	5	6
27	1	9	4	6	7
30	1	10	5	6	8
33	1	11	5	6	10
36	1	12	5	6	12
39	1	13	6	7	12
42	1	14	6	8	13
48	1	16	8	9	14
54	1	18	8	10	17

TABLE OF DECIMAL EQUIVALENTS OF SCREW GAUGE

FOR MACHINE AND WOOD SCREWS.

The difference between consecutive sizes is .01316" for American Screw Co. Standard; .013" for A. S. M. E. Standard.

No. of Screw Gauge.	Size of Number in Decimals.		No of Screw Gauge.	Size of Number in Decimals.		No. of Screw Gauge.	Size of No. in Decimals.
	American Screw Co. Standard.	A.S.M.E. Basic and Maximm Outside Diameter		American Screw Co. Standard.	A.S.M.E. Basic and Maximm Outside Diameter		American Screw Co. Standard.
000	.03152		16	.26840	.268	34	.50523
00	.04468		17	.28156		35	.51844
0	.05784	.060	18	.29472	294	36	.53160
1	.07100	.073	19	.30788		37	.54476
2	.08416	.086	20	.32104	.320	38	.55792
3	.09732	.099	21	.33420		39	.57108
4	.11048	.112	22	.34736	.346	40	.58424
5	.12364	.125	23	.36052		41	.59740
6	.13680	.138	24	.37368	.372	42	.61056
7	.14996	.151	25	.38684		43	.62372
8	.16312	.164	26	.40000	.398	44	.63688
9	.17628	.177	27	.41316		45	.65004
10	.18944	.190	28	.42632	.424	46	.66320
11	.20260		29	.43948		47	.67636
12	.21576	.216	30	.45264	.450	48	.68952
13	.22892		31	.46580		49	.70268
14	.24208	.242	32	.47896		50	.71584
15	.25524		33	.49212			

SUGGESTIONS FOR ORDERING CUTTERS.

Regular Cutters.—Always order by catalogue number giving diameter, face and size of hole.

Special Milling Cutters.—Give diameter, face, size of hole and keyway and refer to catalogue number for style. When End Mills, Angular Mills, Facing Mills and T Slot Cutters are desired, be particular to state whether Right or Left Hand.

Formed Cutters.—Sketches showing form and all dimensions, or template showing form together with all dimensions should be furnished when ordering Formed Cutters. Also state whether Cutter is "coming" or "going" at the bottom. Formed Cutters are adopted for work where uniformity is required, and are sharpened by grinding the faces of the teeth.

Gear Cutters.—Give number of cutter and diametral pitch when ordering. Diametral pitch means the number of teeth to the inch in diameter in pitch circle of any wheel. These cutters are sharpened by grinding the faces of the teeth.

To get best results be sure Cutters are Kept Sharp.

STANDARD KEYWAY FOR CUTTERS.

Diameter (D), Inches	Width (W), Inches.	Depth (a), Inches.	Radius (R), Inches
3/8 to 9/16	3/32	3/64	.020
5/8 to 7/8	1/8	1/16	.030
15/16 to 1 1/8	5/32	5/64	.035
1 3/16 to 1 3/8	3/16	3/32	.040
*1 7/16 to 1 3/4	1/4	1/8	.050
*1 13/16 to 2	5/16	5/32	.060
2 1/16 to 2 1/2	3/8	3/16	.060
2 9/16 to 3	7/16	7/16	.060

* All Gear Cutters with holes 1½, 1¾, and 2 inches diameter have Keyways for 5/16, ⅜ and ½ inch Keys respectively.

MILLING CUTTERS.

TABLE OF CUTTING SPEEDS.

Diam. Inches.	Feet Per Minute.					Diam. Inches.	Feet Per Minute.				
	5	10	15	20	25		5	10	15	20	25
	Revolutions Per Minute.						Revolutions Per Minute.				
½	38.2	76.4	114.6	152.9	191.1	8	2.4	4.8	7.2	9.6	11.9
⅝	30.6	61.2	91.8	122.5	153.1	9	2.1	4.2	6.4	8.5	10.6
¾	25.4	50.8	76.3	101.7	127.1	10	1.9	3.8	5.7	7.6	9.6
⅞	21.8	43.6	65.5	87.3	109.1	11	1.7	3.5	5.2	6.9	8.7
1	19.1	38.2	57.3	76.4	95.5	12	1.6	3.2	4.8	6.4	8.0
1⅛	17.0	34.0	51.0	68.0	85.0	13	1.5	2.9	4.4	5.9	7.3
1¼	15.3	30.6	45.8	61.2	76.3	14	1.4	2.7	4.1	5.5	6.8
1⅜	13.9	27.8	41.7	55.6	69.5	15	1.3	2.5	3.8	5.1	6.4
1½	12.7	25.4	38.2	50.8	63.7	16	1.2	2.4	3.6	4.8	6.0
1⅝	11.8	23.5	35.0	47.0	58.8	17	1.1	2.2	3.4	4.5	5.6
1¾	10.9	21.8	32.7	43.6	54.5	18	1.1	2.1	3.2	4.2	5.3
1⅞	10.2	20.4	30.6	40.7	50.9	19	1.0	2.0	3.0	4.0	5.0
2	9.6	19.1	28.7	38.2	47.8	20	1.0	1.9	2.9	3.8	4.8
2¼	8.5	17.0	25.4	34.0	42.4	21	.9	1.8	2.7	3.6	4.5
2½	7.6	15.3	22.9	30.6	38.2	22	.9	1.7	2.6	3.5	4.3
2¾	6.9	13.9	20.8	27.8	34.7	23	.8	1.7	2.5	3.3	4.1
3	6.4	12.7	19.1	25.5	31.8	24	.8	1.6	2.4	3.2	4.0
3½	5.5	10.9	16.4	21.8	27.3	25	.8	1.5	2.3	3.1	3.8
4	4.8	9.6	14.3	19.1	23.9	26	.7	1.5	2.2	2.9	3.7
4½	4.2	8.5	12.7	16.9	21.2	27	.7	1.4	2.1	2.8	3.5
5	3.8	7.6	11.5	15.3	19.1	28	.7	1.4	2.0	2.7	3.4
5½	3.5	6.9	10.4	13.9	17.4	29	.7	1.3	2.0	2.6	3.3
6	3.2	6.4	9.6	12.7	15.9	30	.6	1.3	1.9	2.5	3.2
7	2.7	5.5	8.1	10.9	13.6						

The above table will be convenient for finding the number of revolutions per minute required to give a periphery speed from 5 to 50 feet per minute of diameters from ½ to 30 inches.

Examples.—A mill 2 inches in diameter, to have a periphery speed of 35 feet per minute, should make about 67 revolutions, while a 1⅛ inch mill should make 120 revolutions to have the same periphery speed. If a ¾ inch mill makes 250 revolutions per minute, the periphery speed is about 50 feet.

Continued on next page.

MILLING CUTTERS—Continued.

TABLE OF CUTTING SPEEDS.

Diam. Inches	Feet Per Minute.					Diam. Inches	Feet Per Minute.				
	30	35	40	45	50		30	35	40	45	50
	Revolutions Per Minute						Revolutions Per Minute				
½	229.3	267.5	305.7	344.0	382.2	8	14.3	16.7	19.1	21.1	23.9
⅝	183.7	214.3	244.9	275.5	306.1	9	12.7	14.9	17.0	19.1	21.2
¾	152.5	178.0	203.4	228.8	254.2	10	11.5	13.4	15.3	17.2	19.1
⅞	130.9	152.7	174.5	196.3	218.9	11	10.4	12.2	13.9	15.6	17.4
1	114.6	133.8	152.9	172.0	191.1	12	9.6	11.1	12.7	14.3	15.9
1⅛	102.0	119.0	136.0	153.0	170.0	13	8.8	10.3	11.8	13.2	14.7
1¼	91.8	106.9	122.5	137.4	153.1	14	8.1	9.6	10.9	12.3	13.6
1⅜	83.3	97.2	111.1	125.0	138.9	15	7.6	8.9	10.2	11.5	12.7
1½	76.3	89.2	101.7	114.6	127.1	16	7.2	8.4	9.6	10.7	11.9
1⅝	70.5	82.2	93.9	105.7	117.4	17	6.7	7.9	9.0	10.1	11.2
1¾	65.5	76.4	87.3	98.2	109.1	18	6.4	7.4	8.5	9.6	10.6
1⅞	61.1	71.3	81.5	91.9	101.9	19	6.0	7.0	8.0	9.1	10.1
2	57.3	66.9	76.4	86.0	95.5	20	5.7	6.7	7.6	8.6	9.6
2¼	51.0	59.4	68.0	76.2	85.0	21	5.5	6.4	7.3	8.1	9.1
2½	45.8	53.5	61.2	68.8	76.3	22	5.2	6.1	6.9	7.8	8.7
2¾	41.7	48.6	55.6	62.5	69.5	23	5.0	5.8	6.6	7.5	8.3
3	38.2	44.6	51.0	57.3	63.7	24	4.8	5.6	6.4	7.2	8.0
3½	32.7	38.2	43.6	49.1	54.5	25	4.6	5.3	6.1	6.9	7.6
4	28.7	33.4	38.2	43.0	47.8	26	4.4	5.1	5.9	6.6	7.3
4½	25.4	29.6	34.0	38.1	42.4	27	4.2	5.0	5.7	6.4	7.1
5	22.9	26.7	30.6	34.4	38.2	28	4.1	4.8	5.5	6.1	6.8
5½	20.8	24.3	27.8	31.3	34.7	29	4.0	4.6	5.3	5.9	6.6
6	19.1	22.3	25.5	28.7	31.8	30	3.8	4.3	5.1	5.7	6.4
7	16.4	19.1	21.8	24.6	27.3						

The above table will be convenient for finding the number of revolutions per minute required to give a periphery speed from 5 to 50 feet per minute of diameters from ½ to 30 inches.

Examples.—A mill 2 inches in diameter, to have a periphery speed of 35 feet per minute, should make about 67 revolutions, while a 1⅛ inch mill should make 120 revolutions to have the same periphery speed. If a ¾ inch mill makes 250 revolutions per minute, the periphery speed is about 50 feet.

THE U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL, 1893.

There is in this country no uniform or standard gauge, and the same numbers in different gauges represent different thicknesses of sheets or plates. This has given rise to much misunderstanding and friction between employers and workmen and mistakes and frauds between dealers and consumers.

An Act of Congress in 1893 established the Standard Gauge for sheet iron and steel which is given on next page. It is based on the fact that a cubic foot of iron weighs 480 pounds.

A sheet of iron 1 foot square and 1 inch thick weighs 40 pounds. or 640 ounces, and 1 ounce in weight should be 1–640 inch thick. The scale has been arranged so that each descriptive number represents a certain number of ounces in weight and an equal number of 640ths of an inch in thickness.

The law enacts that on and after July 1, 1893, the new gauge shall be used in determining duties and taxes levied on sheet and plate iron and steel; and that in its application a variation of 2½ per cent. either way may be allowed.

U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL, 1893.

TAKEN FROM KENT'S MECHANICAL ENGINEERS' POCKET-BOOK.

Number of Gauge.	Approximate Thickness in Fractions of an Inch.	Approximate Thickness in Decimal Parts of an Inch.	Approximate Thickness in Millimeters.	Weight per Square Foot in Ounces Avoirdupois.	Weight per Square Foot in Pounds Avoirdupois.	Weight per Square Foot in Kilograms.	Weight per Square Meter in Kilograms.	Weight per Square Meter in Pounds Avoirdupois.
0000000	1-2	0.5	12.7	320	20.	9.072	97.65	215.28
000000	15-32	0.46875	11.90625	300	18.75	8.505	91.55	201.82
00000	7-16	0.4375	11.1125	280	17.50	7.938	85.44	188.37
0000	13-32	0.40625	10.31875	260	16.25	7.371	79.33	174.91
000	3-8	0.375	9.525	240	15.	6.804	73.24	161.46
00	11-32	0.34375	8.73125	220	13.75	6.237	67.13	148.00
0	5-16	0.3125	7.9375	200	12.50	5.67	61.03	134.55
1	9-32	0.28125	7.14375	180	11.25	5.103	54.93	121.09
2	17-64	0.265625	6.746875	170	10.625	4.819	51.88	114.37
3	1-4	0.25	6.35	160	10.	4.536	48.82	107.64
4	15-64	0.234375	5,953125	150	9.375	4.252	45.77	100.91
5	7-32	0.21875	5.55625	140	8.75	3.969	42.72	94.18
6	13-64	0.203125	5.159375	130	8.125	3.685	39.67	87.45
7	3-16	0.1875	4.7625	120	7.5	3.402	36.62	80.72
8	11-64	0.171875	4.365625	110	6.875	3.118	33.57	74.00
9	5-32	0.15625	3.96875	100	6.25	2.835	30.52	67.27
10	9-64	0.140625	3.571875	90	5.625	2.552	27.46	60.55
11	1-8	0.125	3.175	80	5.	2.268	24.41	53.82
12	7-64	0.109375	2.778125	70	4.375	1.984	21.36	47.09
13	3-32	0.09375	2.38125	60	3.75	1.701	18.31	40.36
14	5-64	0.078125	1.984375	50	3.125	1.417	15.26	33.64
15	9-128	0.0703125	1.7859375	45	2.8125	1.276	13.73	30.27
16	1-16	0.0625	1.5875	40	2.5	1.134	12.21	26 91

U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL, 1893.

TAKEN FROM KENT'S MECHANICAL ENGINEERS' POCKET-BOOK.

Number of Gauge	Approximate Thickness in Fractions of an Inch.	Approximate Thickness in Decimal Parts of an Inch.	Approximate Thickness in Millimeters.	Weight per Square Foot in Ounces Avoirdupois.	Weight per Square Foot in Pounds Avoirdupois.	Weight per Square Foot in Kilograms.	Weight per Square Meter in Kilograms.	Weight per Square Meter in Pounds Avoirdupois.
17	9-160	0.05625	1.42875	36	2.25	1.021	10.99	24.22
18	1-20	0.05	1.27	32	2.	0.9072	9.765	21.53
19	7-160	0.04375	1.11125	28	1.75	0.7938	8.544	18.84
20	3-80	0.0375	0.9525	24	1.50	0.6804	7.324	16.15
21	11-320	0.034375	0.873125	22	1.375	0.6237	6.713	14.80
22	1-32	0.03125	0.793750	20	1.25	0.567	6.103	13.46
23	9-320	0.028125	0.714375	18	1.125	0.5103	5.49	12.11
24	1-40	0.025	0.635	16	1.	0.4536	4.882	10.76
25	7-320	0.021875	0.555625	14	0.875	0.3969	4.272	9.42
26	3-160	0.01875	0.47625	12	0.75	0.3402	3.662	8.07
27	11-640	0.0171875	0.4365625	11	0.6875	0.3119	3.357	7.40
28	1-64	0.015625	0.396875	10	0.625	0.2835	3.052	6.73
29	9-640	0.0140625	0.3571875	9	0.5625	0.2551	2.746	6.05
30	1-80	0.0125	0.3175	8	0.5	0.2268	2.441	5.38
31	7-640	0.0109375	0.2778125	7	0.4375	0.1984	2.136	4.71
32	13-1280	0.01015625	0.25796875	6½	0.40625	0.1843	1.983	4.37
33	3-320	0.009375	0.238125	6	0.375	0.1701	1.831	4.04
34	11-1280	0.00859375	0.21828125	5½	0.34375	0.1559	1.678	3.70
35	5-640	0.0078125	0.1984375	5	0.3125	0.1417	1.526	3.36
36	9-1280	0.00703125	0.17859375	4½	0.28125	0.1276	1.373	3.03
37	17-2560	0.00664062	0.16867187	4¼	0.26562	0.1205	1.297	2.87
38	1-160	0.00625	0.15875	4	0.25	0.1134	1.221	2.69

WEIGHT OF IRON AND STEEL SHEETS

WEIGHTS PER SQUARE FOOT

TAKEN FROM KENT'S MECHANICAL ENGINEERS' POCKET BOOK

THICKNESS BY BIRMINGHAM GAUGE				THICKNESS BY BIRMINGHAM GAUGE			
Number of Gauge	Thickness in Inches	Iron	Steel	Number of Gauge	Thickness in Inches	Iron	Steel
0000	.454	18.16	18.52	17	058	2.32	2.37
000	.425	17.00	17.34	18	.049	1.96	2.00
00	.38	15.20	15.50	19	.042	1.68	1.71
0	.34	13.60	13.87	20	.035	1.40	1.43
1	.3	12.00	12.24	21	032	1.28	1.31
2	.284	11.36	11.59	22	.028	1.12	1.14
3	259	10.36	10.57	23	.025	1.00	1.02
4	.238	9.52	9.71	24	022	.88	898
5	.22	8.80	8.98	25	.02	.80	.816
6	.203	8.12	8.28	26	.018	.72	.734
7	.18	7.20	7.34	27	.016	.64	.653
8	165	6.60	6.73	28	.014	.56	.571
9	.148	5.92	6.04	29	.013	.52	.530
10	.134	5.36	5.47	30	.012	.48	.490
11	.12	4.80	4.90	31	.01	.40	.408
12	.109	4.36	4.45	32	.009	.36	.367
13	.095	3.80	3.88	33	.008	.32	.326
14	.083	3.32	3.39	34	.007	.28	.286
15	.072	2.88	2.94	35	.005	.20	.204
16	.065	2.60	2.65				

	Iron	Steel
Specific Gravity	7.7	7.854
Weight per Cubic Foot	480	489.6
Weight per Cubic Inch	.2778	2833

WEIGHTS OF SQUARE AND ROUND BARS OF WROUGHT IRON.

IN POUNDS PER LINEAR FOOT.

IRON WEIGHING 480 LBS. PER CUBIC FOOT FOR STEEL ADD 2 PER CENT

TAKEN FROM KENT'S MECHANICAL ENGINEERS' POCKET-BOOK.

Thickness or Diameter in Inches.	Weight of Square Bar One Foot Long.	Weight of Round Bar One Foot Long.	Thickness or Diameter in Inches.	Weight of Square Bar One Foot Long.	Weight of Round Bar One Foot Long.
0					
1/16	.013	.010	2½	20.83	16.36
⅛	.052	.041	9/16	21.89	17.19
3/16	.117	.092	⅝	22.97	18.04
¼	.208	.164	11/16	24.08	18.91
5/16	.326	.256	¾	25.21	19.80
⅜	.469	.368	13/16	26.37	20.71
7/16	.638	.501	⅞	27.55	21.64
½	.833	.654	15/16	28.76	22.59
9/16	1.055	.828	3	30.00	23.56
⅝	1.302	1.023	1/16	31.26	24.55
11/16	1.576	1.237	⅛	32.55	25.57
¾	1.875	1.473	3/16	33.87	26.60
13/16	2.201	1.728	¼	35.21	27.65
⅞	2.552	2.004	5/16	36.58	28.73
15/16	2.930	2.301	⅜	37.97	29.82
1	3.333	2.618	7/16	39.39	30.94
1/16	3.763	2.955	½	40.83	32.07
⅛	4.219	3.313	9/16	42.30	33.23
3/16	4.701	3.692	⅝	43.80	34.40
¼	5.208	4.091	11/16	45.33	35.60
5/16	5.742	4.510	¾	46.88	36.82
⅜	6.302	4.950	13/16	48.45	38.05
7/16	6.888	5.410	⅞	50.05	39.31
½	7.500	5.890	15/16	51.68	40.59
9/16	8.138	6.392	4	53.33	41.89
⅝	8.802	6.913	1/16	55.01	43.21
11/16	9.492	7.455	⅛	56.72	44.55
¾	10.21	8.018	3/16	58.45	45.91
13/16	10.95	8.601	¼	60.21	47.29
⅞	11.72	9.204	5/16	61.99	48.69
15/16	12.51	9.828	⅜	63.80	50.11
2	13.33	10.47	7/16	65.64	51.55
1/16	14.18	11.14	½	67.50	53.01
⅛	15.05	11.82	9/16	69.39	54.50
3/16	15.95	12.53	⅝	71.30	56.00
¼	16.88	13.25	11/16	73.24	57.52
5/16	17.83	14.00	¾	75.21	59.07
⅜	18.80	14.77	13/16	77.20	60.63
7/16	19.80	15.55	⅞	79.22	62.22

WEIGHTS OF SQUARE AND ROUND BARS OF WROUGHT IRON

IN POUNDS PER LINEAR FOOT—CONTINUED.

IRON WEIGHING 480 LBS. PER CUBIC FOOT. FOR STEEL ADD 2 PER CENT.

Thickness or Diameter in Inches	Weight of Square Bar One Foot Long	Weight of Round Bar One Foot Long	Thickness or Diameter in Inches	Weight of Square Bar One Foot Long	Weight of Round Bar One Foot Long
4 15/16	81.26	63.82	7	163.3	128.3
5	83.33	65.45	⅛	169.2	132.9
1/16	85.43	67.10	¼	175.2	137.6
⅛	87.55	68.76	⅜	181.3	142.4
3/16	89.70	70.45	½	187.5	147.3
¼	91.88	72.16	⅝	193.8	152.2
5/16	94.08	73.89	¾	200.2	157.2
⅜	96.30	75.64	⅞	206.7	162.4
7/16	98.55	77.40	8	213.3	167.6
½	100.8	79.19	¼	226.9	178.2
9/16	103.1	81.00	½	240.8	189.2
⅝	105.5	82.83	¾	255.2	200.4
11/16	107.8	84.69	9	270.0	212.1
¾	110.2	86.56	¼	285.2	224.0
13/16	112.6	88.45	½	300.8	236.3
⅞	115.1	90.36	¾	316.9	248.9
15/16	117.5	92.29	10	333.3	261.8
6	120.0	94.25	¼	350.2	275.1
⅛	125.1	98.22	½	367.5	288.6
¼	130.2	102.3	¾	385.2	302.5
⅜	135.5	106.4	11	403.3	316.8
½	140.8	110.6	¼	421.9	331.3
⅝	146.3	114.9	½	440.8	346.2
¾	151.9	119.3	¾	460.2	361.4
⅞	157.6	123.7	12	480.0	377.0

LUBRICANTS FOR CUTTING TOOLS.

Material	Turning	Chucking	Drilling Milling	Reaming	Tapping
Tool Steel	Dry or Oil	Oil or Soda Water	Oil	Lard Oil	Oil
Soft Steel	Dry or Soda Water	Soda Water	Oil or Soda Water	Lard Oil	Oil
Wrought Iron	Dry or Soda Water	Soda Water	Oil or Soda Water	Lard Oil	Oil
Cast Iron	Dry	Dry	Dry	Dry	Oil
Brass	Dry	Dry	Dry	Dry	Oil
Copper	Dry	Oil	Oil	Mixture	Oil
Babbitt	Dry	Dry	Dry	Dry	Oil
Glass			Turpentine	or Kerosene	

Mixture is ⅓ Crude Petroleum, ⅔ Lard Oil. Oil is Lard. When two lubricants are mentioned the first is preferable.

WHAT IS MEANT BY "INCREASE TWIST"?

In order that a drill may be of sufficient strength to resist the torsional strain to which it is subjected in use, without being at the same time so thick at the point as to require excessive force to make it penetrate the work, it has long been customary to form the grooves of gradually decreasing depth from the point to the shank. By this practice the groove is naturally of less area near the shank, and if no means were employed to increase this area there would be a tendency for the chips to clog in the groove.

This difficulty is obviated in the "Increase Twist" drill by gradually increasing the rate of forward traverse of the drill while it is fed to the groove milling cutters, the speed of rotation of the drill remaining constant. Through the ensuing change in the angle of the cutters to the groove, the groove is made wider and its area thereby increased.

WHAT IS MEANT BY "CONSTANT ANGLE"?

In the "Constant Angle" drill the increase of area of groove toward the shank is obtained by a gradual variation of the angle of the cutters to the axis of the drill as the groove is milled, a uniform speed of rotation of the drill being maintained to produce a groove of uniform pitch. This variation widens the groove toward the shank of the drill, and compensates for the reduction of area, which would otherwise result from its diminishing depth, without impairing the efficiency of the cutting lip of the drill at any point by changing the pitch of the groove.

By this means any desired proportion of area of the groove at the point and at the shank can be obtained, the fact remaining that in any form of twist drill the more the groove is enlarged toward the shank the greater the extent to which the torsional strength of the drill is impaired.

In the "Constant Angle" drills the contour, angle, and area of the groove at all parts of its length are proportioned to combine the maximum torsional strength, the most efficient chip clearance, and the best form of cutting lip.

One thorn of experience is worth a whole wilderness of warning.—*Lowell.*

Opportunity, sooner or later, comes to all who work and wish.—*Lord Stanley.*

We must strive to make ourselves really worthy of some employment. We need pay no attention to anything else; the rest is the business of others.—*Bruyere.*

Necessity never made a good bargain.—*Franklin.*

Most people would succeed in small things, if they were not troubled with great ambitions.—*Longfellow.*

If you are poor, distinguish yourself by your virtues; if rich, by your good deeds.—*Joubert.*

A handful of good life is worth a bushel of learning.—*George Herbert.*

Wear your learning like your watch, in a private pocket; and do not pull it out and strike it merely to show that you have one.—*Chesterfield.*

Knowledge is an excellent drug; but no drug has virtue enough to preserve itself from corruption and decay, if the vessel be tainted and impure wherein it is put to keep.—*Montaigne.*

Every hour of lost time is a chance of future misfortune—*Napoleon I.*

There is no time so miserable but a man may be true.—*Shakspeare.*

Nothing in this world is so good as usefulness. It binds your fellow-creatures to you, and you to them; it tends to the improvement of your own character; and it gives you a real importance in society, much beyond what any artificial station can bestow.—*Sir Benj. Brodie.*

A vocation is born to us all; happily most of us meet promptly our twin,—occupation.—*Balzac.*

We judge ourselves by what we feel capable of doing, while others judge us by what we have already done.—*Longfellow.*

It is our actual work which determines our value.—*Geo. Bancroft.*

TUBAL CAIN.

Old Tubal Cain was a man of might
In the days when Earth was young;
By the fierce red light of his furnace bright
The strokes of his hammer rung;
And he lifted high his brawny hand
On the iron glowing clear,
Till the sparks rushed out in scarlet showers,
As he fashioned the sword and spear.
And he sang—"Hurra for my handiwork!
Hurra for the spear and sword!
Hurra for the hand that shall wield them well,
For he shall be king and lord!"

To Tubal Cain came many a one,
As he wrought by his roaring fire,
And each one prayed for a strong steel blade
As the crown of his desire;
And he made them weapons sharp and strong,
Till they shouted loud for glee,
And gave him gifts of pearl and gold,
And spoils of the forest free.
And they sang—"Hurra for Tubal Cain,
Who has given us strength anew!
Hurra for the smith, hurra for the fire,
And hurra for the metal true!"

CHARLES MACKAY